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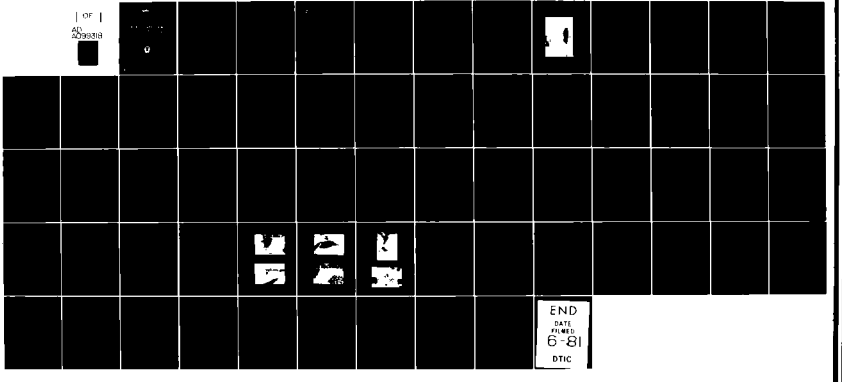

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RARITAN RIVER BASIN
ELECTRIC BROOK, MORRIS COUNTY
NEW JERSEY.

National Dam Safety Program

GEORGE LAKE DAM
(NJ 00825)

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PHASE 1 INSPECTION REPORT.
NATIONAL DAM SAFETY PROGRAM

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Philadelphia District (10) Abraham Perera
Corps of Engineers
Philadelphia, Pennsylvania

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MARCH 1981

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Visual Inspection
Structural Analysis
National Dam Safety Program
Spillways
George Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

12 MAY 1981

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for George Lake Dam in Morris County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, George Lake Dam initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in satisfactory overall condition. The dam's spillway is considered inadequate because a flow equivalent to 33 percent of the One Hundred Year Flood would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within six months from the date of approval of this report, the following remedial actions should be initiated:

(1) Selective removal of trees and brush on the upstream and downstream embankment slopes to lessen the piping potential.

(2) Repair of spalled concrete and repointing of masonry at the spillway.

(3) Removal of silt from the upstream face of the spillway and dam.

c. Periodic inspection of the dam and appurtenant structures should be included in the existing maintenance program.

NAPEN-N
Honorable Brendan T. Byrne

d. Surface creep on the downstream slope should continue to be monitored and corrected when necessary.

e. The blow-off valve should be opened periodically to ensure proper functioning and to keep the intake area free of excessive siltation.

f. An emergency action plan and downstream warning system should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

GEORGE LAKE DAM (NJ00825)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 21 August 1980 by Louis Berger and Associates, Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

George Lake Dam initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in satisfactory overall condition. The dam's spillway is considered inadequate because a flow equivalent to 33 percent of the One Hundred Year Flood would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within six months from the date of approval of this report, the following remedial actions should be initiated:

(1) Selective removal of trees and brush on the upstream and downstream embankment slopes to lessen the piping potential.

(2) Repair of spalled concrete and repointing of masonry at the spillway.

(3) Removal of silt from the upstream face of the spillway and dam.

c. Periodic inspection of the dam and appurtenant structures should be included in the existing maintenance program.

d. Surface creep on the downstream slope should continue to be monitored and corrected when necessary.

e. The blow-off valve should be opened periodically to ensure proper functioning and to keep the intake area free of excessive siltation.

f. An emergency action plan and downstream warning system should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 8 May 1981

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam George Lake Dam Fed ID# NJ 00825 and NJ ID# 127

State Located	New Jersey
County Located	Morris
Coordinates	Lat. 4047.9 - Long. 7447.1
Stream	Electric Brook a.k.a. Stony Brook
Date of Inspection	21 August, 1980

ASSESSMENT OF GENERAL CONDITIONS

George Lake Dam is assessed to be in satisfactory overall condition. The discharge capacity of the main and auxiliary spillways is inadequate, however, being able to accommodate only 32% of the 100-year frequency design storm, and overtopping could occur. However, while overtopping would cause considerable damage to the dam and some downstream property, it is improbable that loss of life would result. It is therefore recommended that this dam be downgraded to the significant hazard category. Remedial actions to be undertaken in the near future include repair of main spillway concrete and masonry, removal of trees from the embankment, and removal of silt from the upstream face of the dam. It is further recommended that more precise H&H studies be performed and that the owner develop (1) written periodic maintenance plans and operating procedures, (2) an emergency action plan, and (3) a downstream warning system.

Abraham Perera P.E.
Project Manager

OVERVIEW OF GEORGE LAKE DAM
AUGUST, 1980

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines can be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I investigations is to identify expeditiously those dams that may pose hazards to human life or property. The assessment of the general condition of the dam is based on available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In the review of this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway test flood is based on the estimated "probable maximum flood" for the region (greatest reasonable possible storm runoff) or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: George Lake Dam FED #NJ 00825
AND NJ ID # 127

SECTION 1 PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The state, in turn, is under agreement with the U.S. Army Corps of Engineers, Philadelphia to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the George Lake Dam and appurtenant structures and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

George Lake Dam, a.k.a. Camp Washington Dam, is a 230-foot-long earth structure with a masonry corewall and a 50-foot-long narrow-crested concrete spillway at the right abutment. This ogee-type structure constricts to about 26 feet about 30 feet downslope. At the constriction, the gradient steepens from 15 to about 38 degrees. An 8-foot-long horizontal apron is located at the toe of the structure. The embankment, which has a maximum height of about 29.5 feet, is 9 feet wide at the crest with 2H:IV and 1.5H:IV slopes upstream and downstream respectively. A slight saddle located at the junction of the dam crest and left abutment appears to have been designed as an auxiliary spillway. A 24-inch-diameter CI drain is located about 125 feet from the left abutment. This outlet presumably has a drop inlet

structure located below the lake level elevation and is controlled from a valve chamber located in the center of the dam crest. The outlet structure consists of a 4.75-foot-high headwall with 4-foot-long wingwalls on the downstream toe of the embankment.

b. Location

George Lake Dam is located on Electric Brook about one mile upstream from its confluence with the South Branch Raritan River. The site is 300 feet east of Camp Washington Road at a point about 2,200 feet north of the junction of that road with Route 24 in the town of Long Valley, Morris County, New Jersey.

c. Size Classification

George Lake Dam is approximately 29.5 feet high and impounds an estimated 88 acre-feet of water at maximum pool elevation. Based on the Recommended Guidelines for Safety Inspection of Dams, this dam is in the small size category.

d. Hazard Classification

George Lake Dam is located in a sparsely populated area of Morris County, New Jersey. Immediately below the dam, the stream descends through a rocky gorge dropping about 300 feet in half a mile. At the foot of the gorge, the valley widens rapidly into the main valley of the South Branch of the Raritan River, where nine homes are located within 300 feet of the stream. The dam experienced failures of varying degrees of intensity on four occasions between its original construction in 1908-09 and August 1942. Although none of the failures resulted in very serious damage to dwellings in the downstream valley, it is believed that new construction in the valley and people using the hiking trails downstream of the dam could be endangered in the event of a sudden failure. In order to verify the hazard classification, a breach analysis was performed assuming a 15-foot-wide break developing within one hour. A maximum flood stage of 4 feet within the stream was developed immediately below the dam and dissipated to 2.2 feet in the area of the

homes 3,000 feet downstream. Accordingly, it is recommended that the dam be downgraded to a significant hazard classification.

e. Ownership

George Lake Dam is currently owned by the Morris County Park Commission, Court House, Morristown, New Jersey, 07960.

f. Purpose of Dam

George Lake Dam is utilized solely for recreational purposes.

g. Design and Construction History

The dam was originally built by the Kennedy Electric Company in 1908-09 under the supervision of the New Jersey Engineering and Construction Company of Morristown, New Jersey. The original dam, which was a 2,100-foot-long timber-crib rock fill structure with a concrete corewall, failed in October 1927, and the existing dam was constructed in 1928. The dam was overtopped in 1940, motivating a one foot increase in the height of the dam to provide additional freeboard. The dam was again overtopped in 1942, prompting the state to request construction of an auxiliary spillway at the left abutment.

h. Normal Operational Procedures

The only regulating device at George Lake Dam is the 24-inch CI drain located near the center of the dam. This is utilized to regulate the elevation of the lake during the recreational summer months and to lower the lake level, if necessary, to prevent ice damage during the winter.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area for George Lake Dam is 2.9 square miles, which consists primarily of undeveloped woodlands with a few small, isolated residential developments.

b. Discharge at Damsite

Maximum known flood at damsite - 1,850 cfs (1942)

Spillway capacity (at maximum pool elevation) - 1,175 cfs

c. Elevation (ft. above MSL)

Top dam - +925.5
Recreation pool - +922.0
Spillway crest - +922.0
Streambed at centerline of dam - 876±

d. Reservoir

Length of maximum pool - 990 feet
Length of recreation pool - 775 feet

e. Storage

Recreation pool - 45± acre-feet
Top of dam - 88± acre-feet

f. Reservoir Surface

Top dam (max. pool) - 9.1 acres
Recreation pool - 4.6 acres

g. Dam

Type - Earth embankment with a concrete spillway
Length - 230 feet
Height - 29.5 feet
Top width - 9 feet
Side slopes - 2H:IV, 1.5H:1V
Zoning - Unknown
Impervious core - Unknown
Cutoff - Masonry corewall to bedrock or impervious till
Grout curtain - None recorded

h. Diversion and Regulating Tunnel

None

i. Spillway

Type - concrete ogee-type weir
Total length of weir - 50 feet
Crest elevation - +922.0
U/S channel - None
D/S channel - Natural stream

j. Regulating Outlets

24-inch CI drain at approximately exit invert elevation 898.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No plans, design drawings, or calculations were available for the evaluation of George Lake Dam. However, several pages of specifications detailed the manner in which the dam was to be constructed. Additionally, the Report on Dam Application prepared by the State Department of Conservation and Development provided pertinent data with respect to dimensions and features of the dam, although some of the information therein was found to be erroneous due to subsequent repairs and modifications.

2.2 CONSTRUCTION

As indicated previously, construction specifications were available for review by the inspection team, as were contruction inspection reports prepared by an engineer from the State Department of Conservation and Development. In addition, subsequent inspection reports and modifications to the dam provide a continuity of construction events at the dam from 1928 to 1948. Inspection reports pertaining to the dam's construction in 1928 indicate that the corewall rests on the Precambrian gniess bedrock from the east abutment to a point 90 feet to the west, where glacial till provides the footing until the west abutment is reached. The gneiss is a hard and durable gray to white granitoid basement rock prevalent in northern New Jersey. The glacial ground moraine is a dense, pre-consolidated heterogeneous mixture of earth and stone resembling, in some areas, a natural, semi-lithified concrete.

2.3 OPERATION

No records of formal operations at the dam were located. Communication with representatives of the present owner indicates that Morris County Park Commission personnel do regulate water levels at the lake and are available all year around for this function, although no codification of this operation exists at the present time.

2.4 EVALUATION

a. Availability

While none of the dam design, construction, drawings, or calculations were available, inspection reports and construction specifications reviewed in conjunction with, and confirmed by, visual inspection, aided in performing an analysis of the hydraulic capacity and structural integrity of the dam.

b. Adequacy

Assuming the validity of information available for review by the inspection team, the data are considered adequate to perform a cogent assessment of the dam's existing condition and capacity.

c. Validity

While the field investigation substantiates the accuracy of most of the available engineering data, some uncertainties exist with respect to elevations and configurations of some of the dam's features. Correspondence dated 1972 put the elevation of the spillway crest at 902, which would make the dam crest 905.5. Correspondence from the 1920s indicates that the dam crest is about at elevation 915. This latter figure is substantiated by the U.S.G.S. quadrangle map, which shows the 920-foot contour terminating in the vicinity of the dam. Subsequent construction raised the dam crest to the existing elevation. Other correspondence indicates that the auxiliary spillway channel crest elevation would be 3 inches higher than the principal spillway crest (i.e., 3.25 feet below dam crest elevation). However, the saddle at the left abutment, if it actually is an auxiliary spillway, appears to be on the order of only 1 to 1 1/2 feet below dam crest elevation. The drop inlet was not seen by the inspection team. Consequently, no data are available with respect to the opening dimensions. While the "Report on Dam Application" indicates that both embankment slopes are 2H:1V, field measurements indicate that the downstream slope

is about 1.5H:1V. Inspection reports indicate that this slope was built a little steeper than it was designed, and later modifications, consisting of raising and widening the dam crest, would accentuate the slope gradient.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspection of George Lake Dam took place on August 21, 1980. At the time of the inspection, about 2 inches of water was passing over the spillway weir. The state of the dam and appurtenant structures was found to be generally fair with no seriously detrimental conditions noted.

b. Dam

The embankment extends approximately 180 feet from the spillway to the relatively steep valley wall forming the left abutment. Modifications to the dam included raising and widening the dam crest slightly, which resulted in a somewhat steeper downstream slope than originally designed. However, vegetation and the use of heavy stone riprap at the toe seems to have mitigated the effects of erosion due to higher velocity runoff. Two exceptions were noted in the area directly above the 24-inch CI drain and adjacent to the spillway's left sidewall. However, while both these areas are devoid of vegetation, the earth is well compacted and erosive forces are not cutting at a very rapid pace. Consequently, it is believed the erosion is due primarily to foot traffic rather than surface runoff. Surface cover on both slopes consists of brush and of trees up to 12 inches in diameter with little substantial grass cover. The dam crest has, with the exception of a slight saddle at the left abutment, a fairly uniform horizontal and vertical alignment and is covered with gravel, providing a path across the valley. The heavy stone riprap at the toe seems to offer excellent stability to the embankment. No seepage or slumping was noted, although the growth angle of some trees on the downstream slope indicates that creep has been, and continues to be, a local on-going, although not critical, process.

c. Appurtenant Structures

The spillway appears to be in faily good alignment and condition. Light surface spalling of the overflow slab was noted on the steeper portion of the spillway where flow velocities, and consequently cavitational effects, are greater. The masonry sidewalls, concrete caps, and sidewall/spillway-slab junction all appear to be in good condition with the exception of the footwall on the right side of the spillway apron, where more severe concrete deterioration has taken place. However, since this wall is footed on, abuts, and is towered over by a massive bedrock outcrop, the deterioration is of none but aesthetic consequence. The footbridge over the spillway is supported on the sidewalls and one narrow pier, offering little constriction to flows prior to a dam overtopping. The gate valve to the 24-inch CI drain could not be inspected since the access cover to the manhole was bolted shut. However, this unit is believed to be in good operable condition since the lake level is reportedly regulated periodically during the year. Water level at the outfall covered two-thirds of the outlet pipe, but it is not certain if this flow was emanating from the pipe or was seeping laterally through the riprap from the principal spillway outlet located about 60 feet to the right of this channel. The portion of the masonry headwall visible appeared in fairly sound condition.

d. Reservoir

The upstream (northwest) area of the lake has a gently wooded slope, whereas the valley walls on both sides of the lake are somewhat steeper and form a gorge in the area of the dam. With the exception of a few buildings and recreational facilities belonging to the Morris County Park Commission, the area immediately around the lake is undeveloped and heavily wooded. Sedimentation in the vicinty of the spillway has filled the lake to within two feet of the spillway crest. Correspondence indicates that heavy siltation has been a problem in the past since the owner requested state permission to use dynamite in an attempt to loosen silt from around the inlet structure for the 24-inch drain.

e. Downstream Channel

The downstream channel follows a narrow, deep, steep-sided gorge to the South Branch Raritan River Valley. The gorge is heavily wooded and boulder strewn along the stream channel. The floor of the gorge averages about 50 feet in width and is from 80 to 180 feet deep, while the slopes of the valley sidewalls range from 1.5H:IV to 2H:IV. About 3,500 feet downstream, the channel passes under Fairview Avenue, where the river enters the South Branch Raritan River Valley.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal operational procedures in effect at George Lake Dam at this time. While there are generally caretaker personnel of the Morris County Park Commission available in the park area on a full-time basis, no set procedures other than upkeep are employed at the dam. When the elevation of the lake water level is regulated, it is in response to specific needs, such as protection from ice, supplementation of low downstream flows, and repair and cleaning of recreational facilities.

4.2 MAINTENANCE OF DAM

Aside from light surface erosion and concrete spalling, the satisfactory nature of the dam condition indicates an adequate caretaking operation. The grounds surrounding the dam were well manicured, and apart from the large trees, the dam itself was clear and well maintained.

4.3 MAINTENANCE OF OPERATING FACILITIES

As indicated in Paragraph 4.1 above, the lake is regulated periodically using the 24-inch drain at the center of the dam. In conjunction with regulation of the lake, the operating controls are routinely inspected, tested, and repaired when necessary.

4.4 DESCRIPTION OF WARNING SYSTEM

There is no formal monitoring system in effect at the lake at present, although camp and park personnel are at the site on a full-time basis and would notify downstream authorities in the event of an emergency situation.

4.5 EVALUATION

The lack of formalized operational procedures at this dam is not considered a serious deficiency since operations and maintenance are performed by attendant personnel on an "as-needed" basis. However, in view

of this dam's past history of overtopping, it is believed that park employees should be instructed to lower the lake level during extended periods of rainfall and a formal set of notification procedures established whereby downstream civil defense authorities or local police would be alerted in the event of impending dam failure or overtopping.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

Based on the criteria in the Recommended Guidelines for Safety Inspection of Dams, George Lake Dam is small in size and is placed in the significant hazard category. Accordingly, a 100-year frequency event was selected as the design storm and an inflow hydrograph calculated using precipitation data from Technical Paper 40 and NOAA Technical Memorandum NWS Hydro-35. Inflow to the reservoir was calculated with the HEC-1 computer program to be 3,771 cfs. The routed discharge was computed to be a peak of 3,640 cfs. Combined capacity of the principal and auxiliary spillways is 1,175 cfs and is, therefore, able to accommodate 32 percent of the design flood.

b. Experience Data

The dam has a history of failure and overtopping (see Section 2). Since 1941, after the dam was increased in height by 1 foot and an auxiliary spillway was provided, no further overtopping was recorded. The calculated maximum capacity of discharge before overtopping was indicated as being 1,880 cfs on design documents, but reduction of the auxiliary spillway width reduced this figure to about 1,175 cfs.

c. Visual Observations

The lake level at the time of inspection was a few inches above the spillway crest. The depression next to the left abutment was measured and found to be approximately 30 feet long and 1.5 feet deep. No evidence was noted that would indicate damage caused by hydraulic or hydrologic action or events.

d. Overtopping Potential

The appended hydraulic analysis indicates that a considerable potential exists for overtopping, primarily because of the limited spillway capacity. The design flood would overtop the dam crest by approximately 1.93 feet.

e. Drawdown Potential

Using the 24-inch-diameter CI pipe in the dam embankment, it would take approximately 15.5 hours to lower the lake to elevation 907.0.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation

Based on the field inspection, the structural stability of the dam is considered adequate, although further deterioration of the spillway surfaces can be expected in the future unless the deteriorated concrete surfaces are repaired. In particular, heavy spalling was noted on the right sidewall near the bottom of the spillway. Along both sidewalls, several separations were noted in the joints of the masonry underlying the concrete. While these defects are not a cause for immediate concern regarding the structural stability of the dam, they should not be left unattended in the future.

b. Design and Construction Data

The available official correspondence on this dam and the present inspection indicate that the dam was reconstructed following its failure in 1927 and that it overtopped in 1940 and 1942 with considerable damage caused each time. Since 1942, following the increase in the height of the dam and provision of an auxiliary spillway, no further overtopping has been recorded, although in 1949 the dam required the removal of silt at the upstream end of the outlet and repairs because of leakage and cracks in the spillway.

c. Operating Records

Written operating records are non-existent.

d. Post Construction Changes

According to available documentation of the dam, several modifications and repairs were undertaken at this site up to 1942. Although no engineering plans, with exception of one sketch of the dam cross section, were available to describe the construction changes made, sufficient written description is given in the past correspondence on the dam to indicate, with adequate detail for the purposes of this inspection, the changes that were made.

e. Seismic Stability

The dam is located in Seismic Zone 1, and because of its embankment height-width ratio, it is negligibly vulnerable to earthquake loading intensities as it is statically stable. Experience indicates that dams in Zone 1 will be adequately stable under dynamic loadings if they are stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ PROPOSED REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection, George Lake Dam is classified as being in fair overall structural condition, although the spillways are incapable of passing the design flood. On the basis of available information, the dam embankment is believed to be sufficiently impervious to withstand normal hydraulic heads. The present spillway capacity does not meet the requirements of the Recommended Guidelines for Safety Inspection of Dams, as it is able to accommodate only 32 percent of the design flood as calculated by Corps of Engineers criteria. The calculated spillway design flood would overtop the dam by 1.93 feet, causing damage primarily to the downstream face.

b. Adequacy of Information

The information gathered for the Phase I inspection is deemed to be adequate regarding the structural stability of the dam.

c. Urgency

It is recommended that the remedial measures enumerated below be undertaken in the near future.

d. Necessity for Further Study

Since the spillway capacity is inadequate, it is recommended that more precise H&H studies be undertaken. Should modifications to increase the spillway capacity of the dam be contemplated, additional engineering studies would also be required.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Recommendations

Remedial measures that should be considered as being part of the normal maintenance of the dam and implemented in the near future include:

1. Selective removal of trees and brush on the upstream and downstream embankment slopes to lessen piping potential.

2. Repair of spalled concrete and repointing of masonry at the spillway.

3. Removal of silt from the upstream face of the spillway and dam.

b. O&M Maintenance and Procedures

The present maintenance program is considered satisfactory within the limits of the program. However, periodic inspection of the dam and appurtenant structures should be included in the program. In this respect, the surface creep on the downstream slope and the spillway deterioration should continue to be monitored and corrected when deemed necessary. It is recommended that the blow-off valve be opened periodically to ensure its proper functioning and to keep the intake area free of excessive siltation. It is further recommended that the owner of the dam develop an emergency action plan (EAP) and warning system to minimize the potential for flood damage downstream. As a minimum, the EAP should include the release of water through the blow-off in anticipation of, or during, severe storms and excessive runoff.

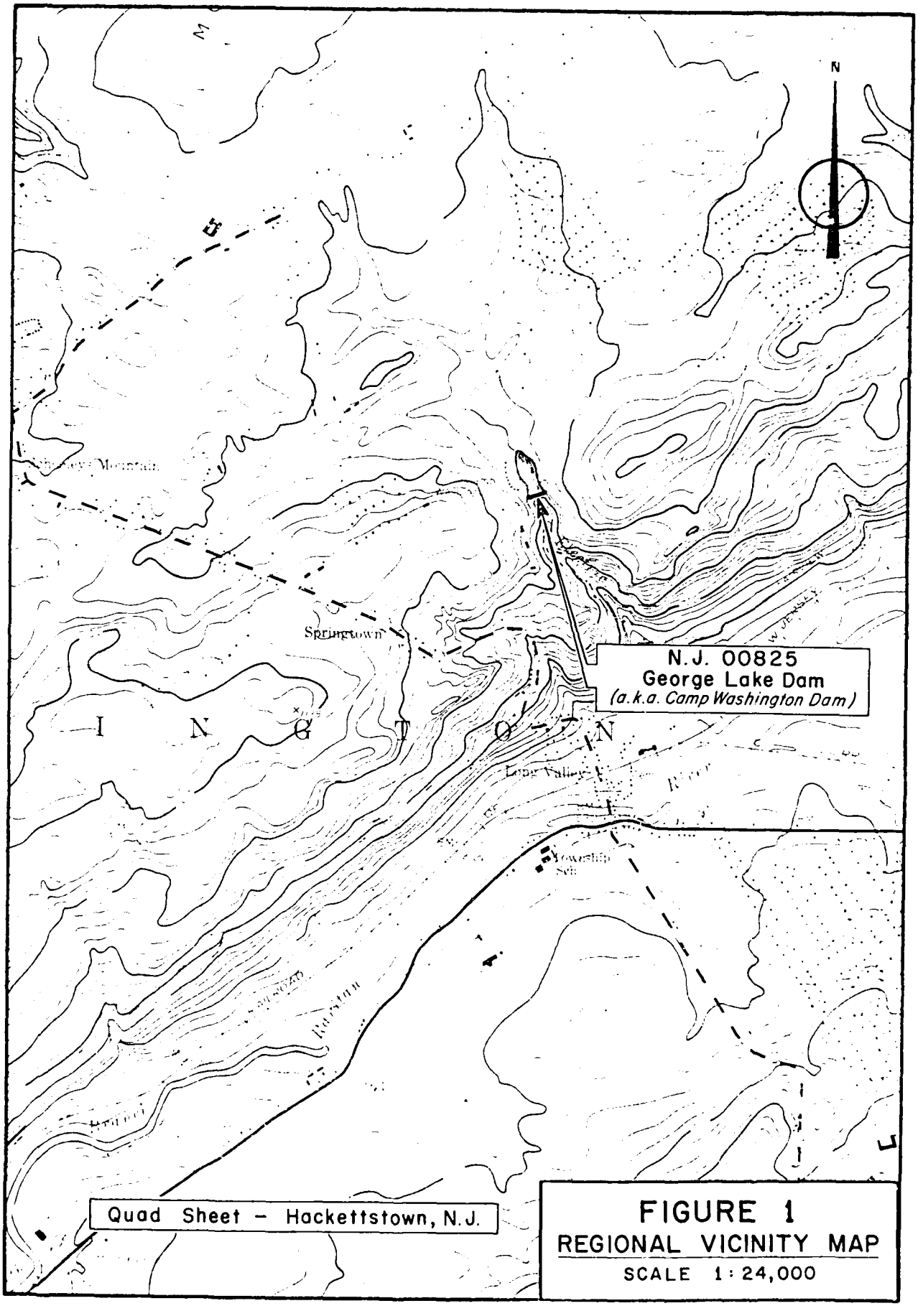
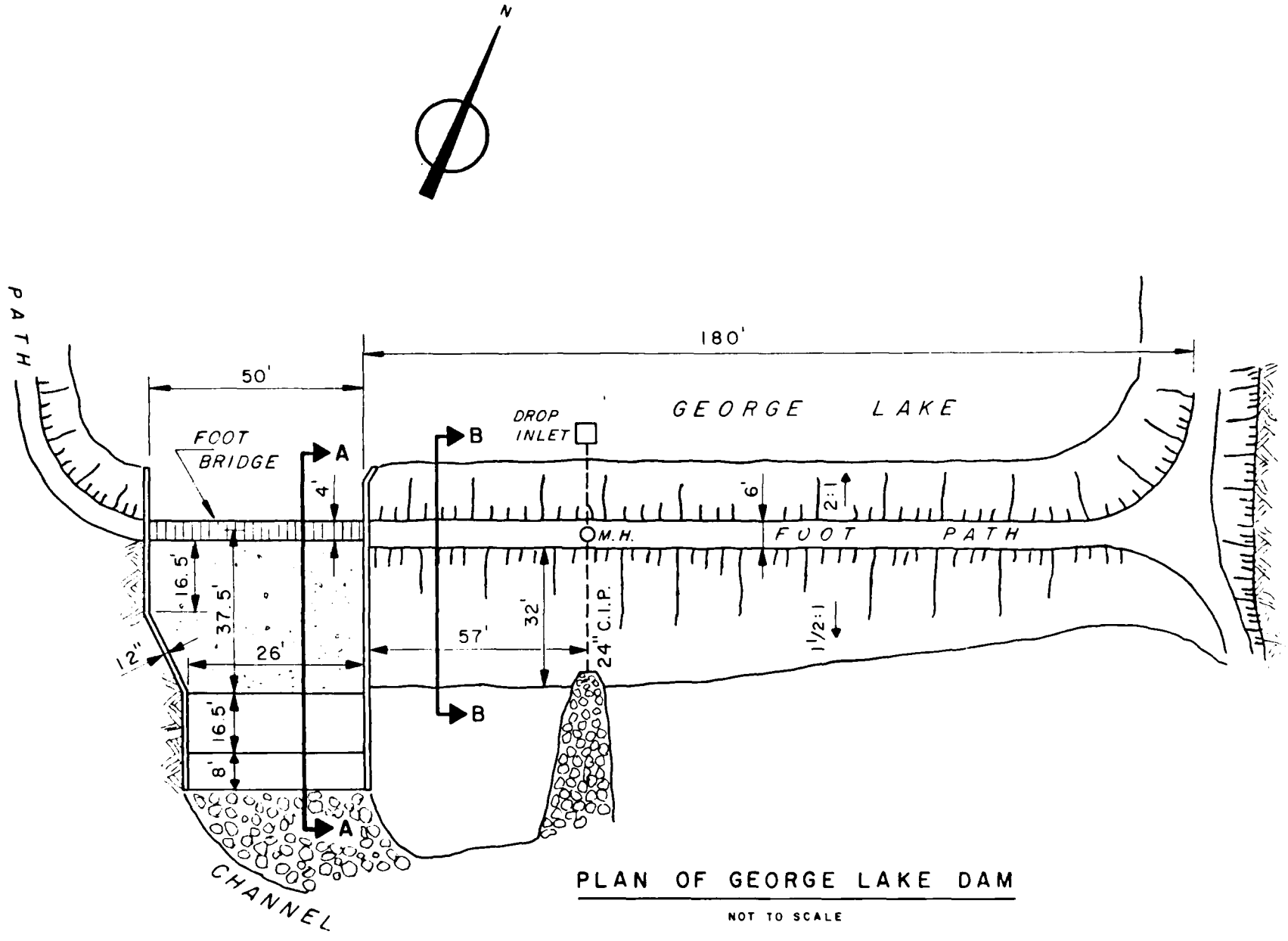


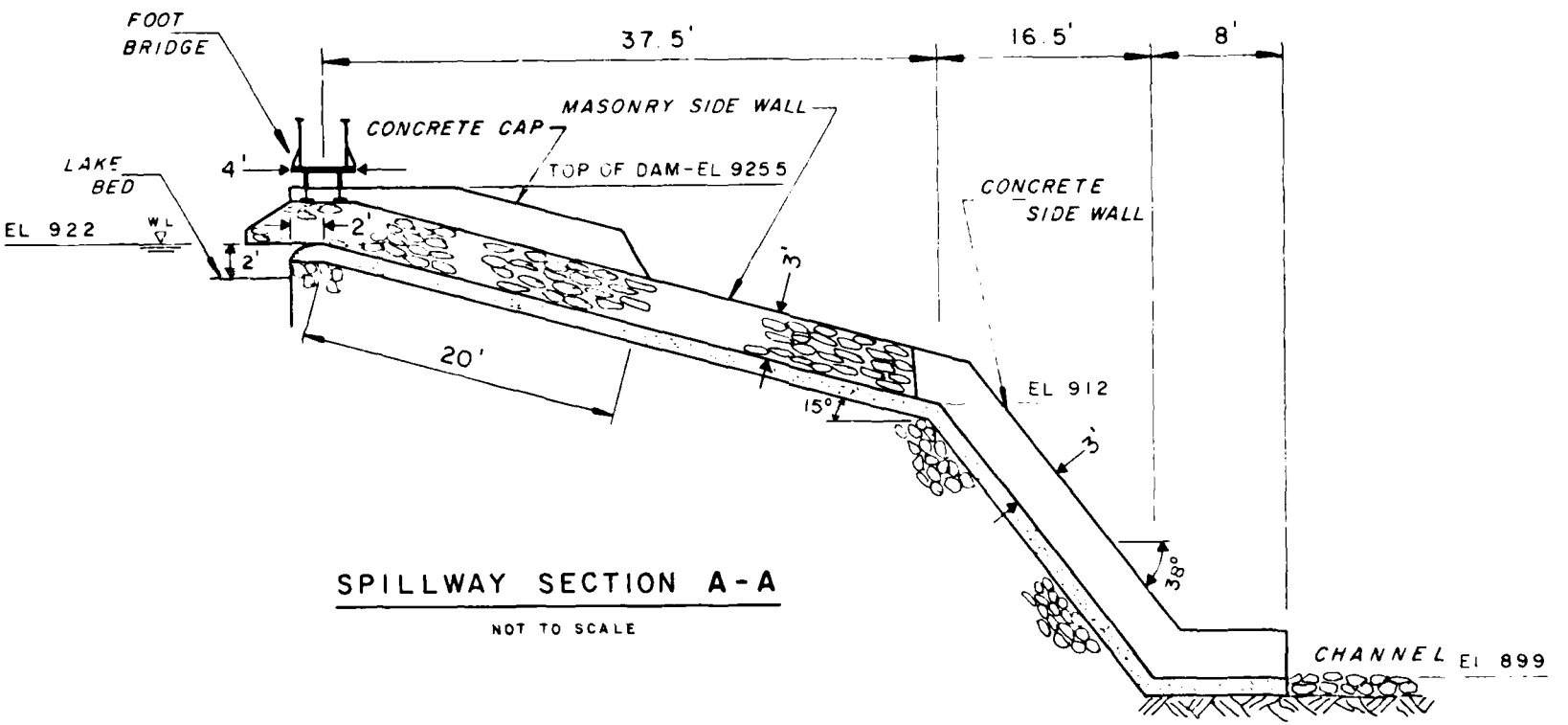
FIGURE 1
REGIONAL VICINITY MAP
SCALE 1:24,000



PLAN OF GEORGE LAKE DAM

NOT TO SCALE

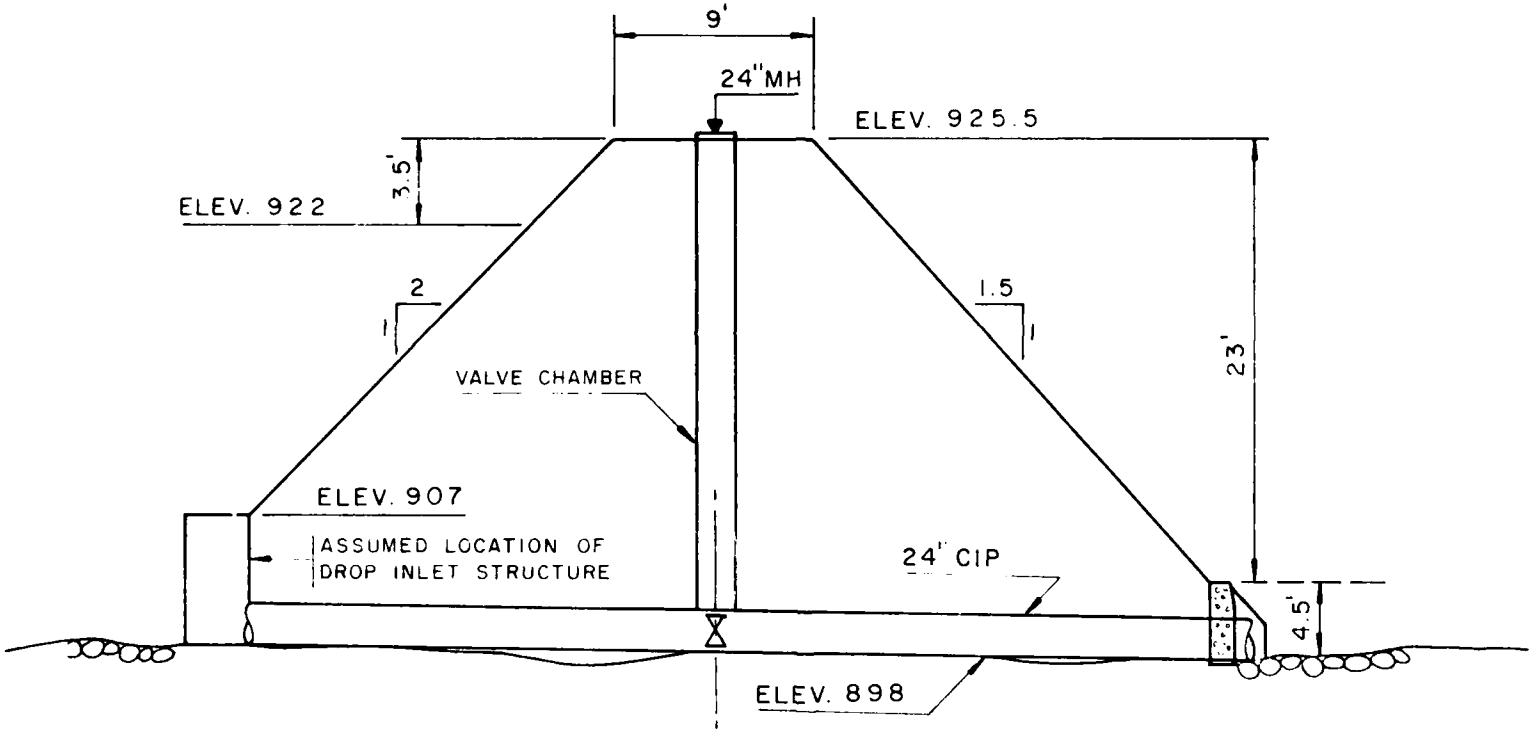
FIGURE 2



SPILLWAY SECTION A-A

NOT TO SCALE

FIGURE 3



TYPICAL DAM SECTION B - B

SHOWN SCHEMATICALLY (NOT TO SCALE)

FIGURE 4

Check List
Visual Inspection
Phase I

Name Dam George Lake Dam County Morris State New Jersey Coordinates N.J.D.E.P.

Date(s) Inspection 21 Aug. 1980 Weather Clear Temperature 80°

Pool Elevation at Time of Inspection 902.1 M.S.L. Tailwater at Time of Inspection 879 M.S.L.

Inspection Personnel:

A. Perera	T. Chapter	
J. Greenstein		
R. Lang		

T. Chapter Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None Observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None Observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Some erosion in area of outlet pipe and left sidewall of spillway. Angle of tree growth indicates some localized creep has occurred in past and may still be in progress.	Very large stone on bottom half of slope and toe appear to have been placed to stop erosion or sloughing. Embankment has stabilized. Creep is so slow as to be insignificant.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal alignment is satisfactory. Slight saddle at left abutment appears to be auxiliary spillway. Vertical alignment satisfactory. Slopes are uniform. No distortion noted.	Later conversation with caretaker confirms crest saddle is auxiliary spillway.
RIPRAP FAILURES	N/A	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Brush and trees up to 12 inches in diameter on both slopes, Grass cover is spotty.	Heavy growth should be cleared and thicker more durable grass cover established.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Satisfactory - No cracking, separation or detrimental conditons noted with exception of spillway left footwall and embankment toe where toe/channel transition is rather sharp.	More stone should be placed along toe at the left side of the head of the spillway channel.
ANY NOTICEABLE SEEPAGE	No noticeable seepage on slopes or along toe. However, runoff from the spillway channel may be moving laterally through stone at toe to the outlet pipe channel.	Lateral water movement at toe is not considered significant if it exists. Outlet pipe is jammed partially open. Material causing jam later removed by flushing.
STAFF GAGE AND RECORDER	None	
SLIDES	Unknown	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet conduit not observed.	
INTAKE STRUCTURE	Not observed. Below lake level about 50 feet upstream from crest.	
OUTLET STRUCTURE	Masonry head and wingwalls. Satisfactory condition. Outlet pipe and channel about 2/3 full of water. Light erosion around wingwalls.	Valve was determined to be partially open. Condition subsequently corrected.
OUTLET CHANNEL	Well defined, very stoney bottom with gentle stone covered side slopes and considerable vegetation on valley floor. Some bank erosion.	Channel condition is satisfactory.
EMERGENCY GATE	Not observed. Gate valve located in sealed manhole.	Reportedly operated periodically during the year.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Good alignment. No appreciable concrete deteriorationat crest. Steeper portion of spillway slab exhibits light cavitational spalling. Foot of right sidewall shows greater concrete deterioation.	Sidewall abuts bedrock so concrete patching only necessary for aesthetics. Spillway slab should be monitored for additional wear but repair is unnecessary at this time.
APPROACH CHANNEL	Not applicable	
DISCHARGE CHANNEL	Well defined, very stony channel follows right side of valley. Vertical bedrock wall on right changing tc steep rocky, vegetated slope downstream. Joined by outlet channel about 200 feet downstream.	
BRIDGE AND PIERS	Footbridge over crest with narrow pier in center.	Bottom of bridge soffit is at crest elevation of dam. Bridge would not constrict flow until dam is overtopped. Pier is about 1 foot wide. Only slight constriction to flow.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Gently sloping wooded area to northwest of lake. Northwest and southwest side of lake somewhat steeper. Undeveloped park area. Beach and bathhouse on shore.	
SEDIMENTATION	Lake silted up to within 2 feet of spillway crest at this location.	When lake is next lowered, the silt in front of the spillway should be removed to reduce the load on that structure.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Very rocky, narrow, deep gorge extends from dam to Long Valley. Drops about 300 feet in elevation in half a mile.	
SLOPES	Steep sided, heavily wooded, uninhabited valley side slopes.	
APPROXIMATE NO. OF HOMES AND POPULATION	Nine homes are located within 300 feet of Electric Brook in Long Valley. These homes are situated 1000 feet downstream of the Schooley Mountain gorge in an area where the stream is flowing across a broad valley enroute to its confluence with the South Branch Raritan River. A flood wave exiting the gorge would be attenuated by the broad valley floor.	Some cellar flooding reported as result of previous dam break.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Not Available
REGIONAL VICINITY MAP	Available - U.S.G.S. Quad Sheet - Hackettstown, New Jersey
CONSTRUCTION HISTORY	Available - microfilm, N.J.D.E.P., Prospect Street, Trenton, N.J.
TYPICAL SECTIONS OF DAM	Not Available
HYDROLOGIC/HYDRAULIC DATA	Not Available
OUTLETS - PLAN	Not Available
- DETAILS	Not Available
- CONSTRAINTS	Not Available
- DISCHARGE RATINGS	Not Available
RAINFALL/RESERVOIR RECORDS	Not Available

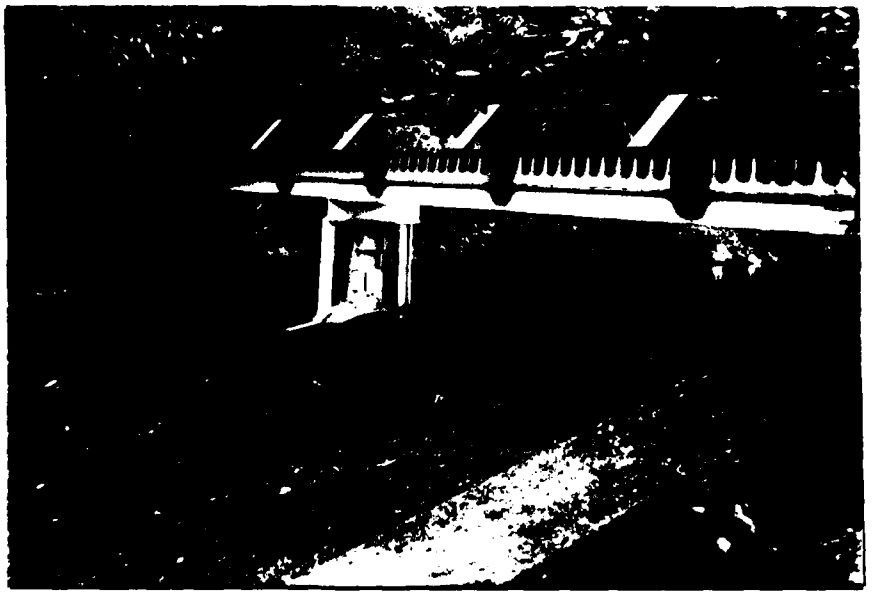
ITEM	REMARKS
SPILLWAY PLAN	Not Available
SECTIONS	Not Available
DETAILS	Not Available
OPERATING EQUIPMENT PLANS & DETAILS	Not Available

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Available - Rutgers Engineering Soil Survey
DESIGN COMPUTATIONS	Not Available
HYDROLOGY & HYDRAULICS	Not Available
DAM STABILITY	Not Available
SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS	Not Available
BORING RECORDS	Not Available
LABORATORY	Not Available
FIELD	Not Available
POST-CONSTRUCTION SURVEYS OF DAM	Not Available
BORROW SOURCES	Not Available

ITEM	REMARKS
MONITORING SYSTEMS	None Available
MODIFICATIONS	Available - Described in N.J.D.E.P. microfilm
HIGH POOL RECORDS	Not Available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not Available
PRIOR ACCIDENTS OR FAILURE OF DAM	
DESCRIPTION	Available - Described on N.J.D.E.P. microfilm
REPORTS	Available - Described on N.J.D.E.P. microfilm Available - Described on N.J.D.E.P. microfilm
MAINTENANCE	
OPERATION	Available - Described by owner's representative
RECORDS	Available - Described by owner's represenetative Not Available

August, 1980

View of Principal Spillway



August, 1980

View of Spillway Crest

August, 1980

View of Dam Crest from Principal Spillway

August, 1980

View of Downstream Face of Dam

August, 1980
View of 24" C.I.P. Outlet Structure

August, 1980
View of Downstream Channel

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 2.9 square miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): +922 MSL (45 acre ft)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: +925.5 MSL(88 acre feet)

CREST:

a. Elevation +922 MSL
b. Type Ogee-type, concrete spillway
c. Width 68 foot long spillway slab and apron
d. Length 50 foot overflow weir
e. Location Spillover Right Abutment
f. Number and Type of Gates None

OUTLET WORKS:

a. Type 24 inch diameter CIP
b. Location 57 feet left of spillway
c. Entrance inverts Unknown
d. Exit inverts Approximately 898 MSL
e. Emergency draindown facilities Same

HYDROMETEROROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE 1,175 cfs

BY DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 4

PROJECT

LOUIS BERGER & ASSOCIATES INC.

BY [illegible] DATE [illegible] SHEET NO. [illegible]
CHKD. BY DATE PROJECT [illegible]
SUBJECT [illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.31	[illegible]
[illegible]	[illegible]	[illegible]	162
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1530
1.75	1.46	0.636	51[illegible]
2.00	1.67	0.511	[illegible]
2.25	1.88	0.33	445
2.50	2.08	[illegible]	337
[illegible]	2.29	[illegible]	[illegible]
3.00	2.50	0.155	131
3.25	2.71	0.112	121
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	3.13	[illegible]	[illegible]
4.00	3.33	0.049	57
[illegible]	3.54	0.035	[illegible]
			Σ 7510

Check [illegible] = [illegible]

LOUIS BERGER & ASSOCIATES INC.

0.25	7	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2.8	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
2.8	3.7	[illegible]	[illegible]
3.0	[illegible]	[illegible]	0.09
[illegible]	3.80	[illegible]	[illegible]
2.00	4.00	[illegible]	.11
2.25	4.11	[illegible]	[illegible]
2.50	4.22	[illegible]	[illegible]
2.75	4.31	0.09	[illegible]
3.00	4.40	0.09	0.70
3.25	4.49	0.09	1.70
3.50	4.57	0.08	0.40
3.75	4.64	0.07	0.30
4.00	4.71	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	
4.50	4.84	0.06	0.09
4.75	4.90	0.06	[illegible]
5.00	4.96	0.06	[illegible]
5.25	5.02	0.06	[illegible]
5.50	5.08	0.06	[illegible]
5.75	5.14	0.06	[illegible]
6.00	5.20	0.06	[illegible]

BY DAT

CHKD BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHEET NO 42 OF

PROJECT

DISCHARGE IN CFS
TOP OF DAM EL. 925.5

BY [illegible] DATE [illegible]
CHKD. BY DATE
SUBJECT [illegible]

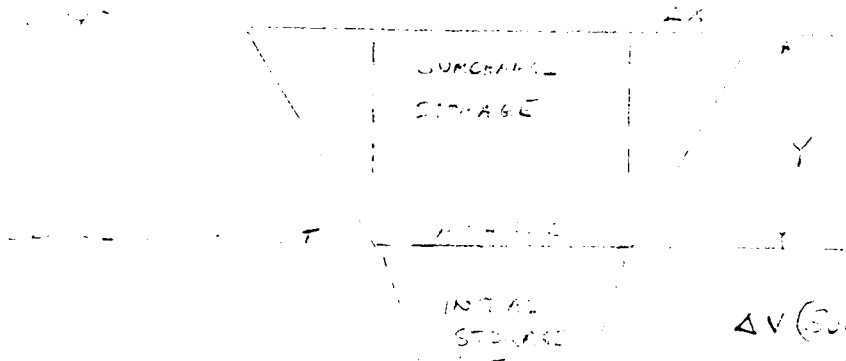
LOUIS BERGER & ASSOCIATES INC.

SHEET NO. [illegible]
PROJECT [illegible]

[illegible] AT ELEVATION OF [illegible] = 1.4 ACRES

[illegible] AT [illegible] = 4.6 ACRES

[illegible] AT 24.0 CONTOUR = 53.3 ACRES



$$\Delta X = \frac{53.3 - 4.6}{18} = \frac{2.71}{2}$$

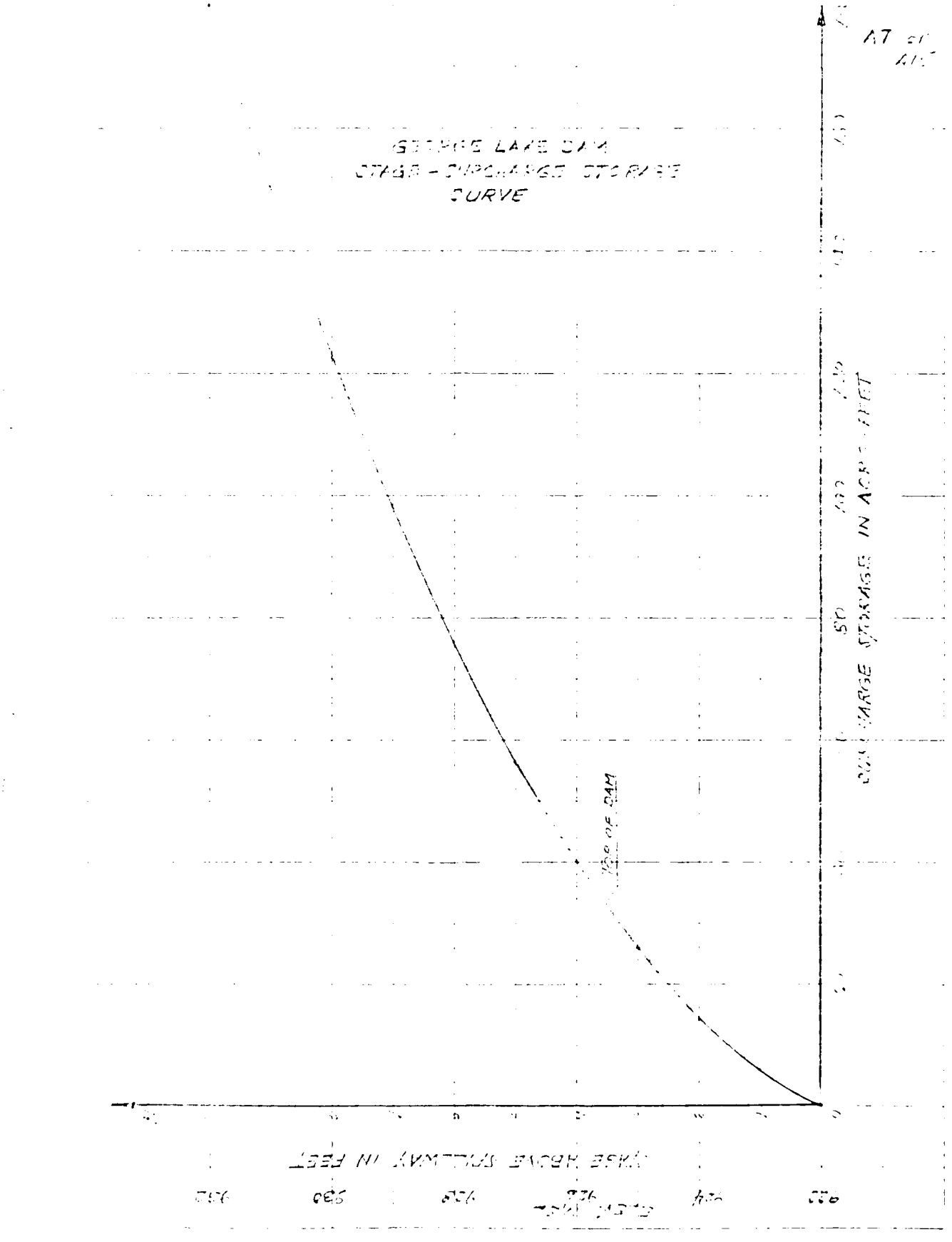
$$\Delta X = 1.35 \text{ AC}$$

ΔV (SURCHARGE STORAGE) =

$$\Delta V = Y(X + \Delta X)$$

[illegible] OF AREA EL. 909 (ACRES)

ELEV.	Y AREA (AC)	X + ΔX AREA (AC)	INITIAL STORAGE (AC-FT)	SURCHARGE STORAGE AC-FT	TOTAL STORAGE AC-FT
[illegible]			0		0
[illegible]	0	[illegible]	45	0	45.0
[illegible]	[illegible]	5.35		[illegible]	51.0
[illegible]	[illegible]	7.3		[illegible]	59.6
[illegible]	[illegible]	[illegible]		[illegible]	71.0
[illegible]	[illegible]	[illegible]		[illegible]	85.0
[illegible]	[illegible]	[illegible]		[illegible]	101.75
[illegible]	[illegible]	[illegible]		[illegible]	121.2
[illegible]	[illegible]	[illegible]		[illegible]	143.35
[illegible]	[illegible]	[illegible]		[illegible]	169.20
[illegible]	[illegible]	[illegible]		[illegible]	195.75
[illegible]	[illegible]	18.1		181.0	226.0
[illegible]	[illegible]	[illegible]		[illegible]	259.0
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]


STEPHS LAKE DAM
STAGE - DISCHARGE STORAGE
CURVE
TOP OF DAM
STAGE ABOVE SPILLWAY IN FEET
DISCHARGE STORAGE IN ACRE - FEET

BY DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. OF

PROJECT

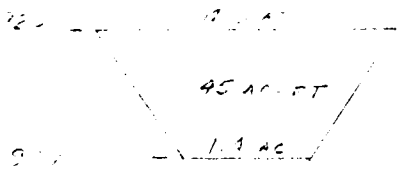
BY ... DATE ...
CHKD. BY ... DATE ...
SUBJECT ...

LOUIS BERGER & ASSOCIATES INC.

...LAKE GAP
DRAWDOWN OF LAKE

SHEET NO ... OF ...
PROJECT ...

...24" ...
...ELEVATION ... TO CREST INLET CREST 907.0
...
...TWICE THAT ... EL 92 ...



$Q = CA\sqrt{H}$

$Q = 0.57 \times 3.14 \sqrt{7.5}$

$Q = 39 \text{ CFS} - 3 \text{ 36 FT}^2$

$C = 0.57$

$A = 3.14$

$H_{AVG} = 7.5$

$$TIME = \frac{45 \text{ AC-FT} \times 43{,}560 \text{ FT}^2/\text{AC}}{36 \times 3600 \text{ SEC/HR}} = 15.16 \text{ HR} \quad \text{SAY } 15.5 \text{ HRS}$$

TO DRAWDOWN TO
ELEV. 907

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO _____ OF _____

CHKD. BY _____ DATE _____ _____ PROJECT _____

SUBJECT _____

```
A1  NSH - DOWNSTREAM CONSEQUENCES OF ASSUMED DAM BREAKS
A2  GEORGE LAKE DAM REC-1 DD
A3  J CERAVOLO  JAN 28 1981
B     200       0      15       0       0       0       0       0       0       0
B1      5
J       1       1       1
J1      1
K       0       1                                               1
K1  INFLOW HYDROGRAPH TO RESERVOIR
M       0      -1     2.9             2.9                                     1
O      24       0
O1  0.06    0.06    0.06    0.06    0.07    0.08    0.09    0.11    0.14     0.3
O1   0.3     0.7     1.7     0.4     0.3    0.16    0.11    0.09    0.09    0.07
O1  0.07    0.06    0.06    0.06
T                                                       0.5     0.1
U      17
U1     98     363     762    1069    1161    1030     814     598     445     337
U1    249     181     131      98      76      57      41
X       0       0       1
K       1       2
K1  ROUTED FLOWS THROUGH RESERVOIR
Y                               1       1
Y1      1                                                       45      -1
Y4    922     923     924     925   925.5     926     927     928     929     930
Y5      0     155     438     839    1175    1629    2928    4575    6496    8652
$S      0      45      81    99.6      71      85   101.8   121.2    68.2   195.8
$E    907     922     923     924     925     926     927     928     930     931
$$    922
$D  925.5
K      99
```

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
200	0	15	0	0	0	0	0	0	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

INFLOW HYDROGRAPH TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	-1	2.90	0.00	2.90	0.00	0.000	0	1	0

PRECIP PATTERN

0.06	0.06	0.06	0.06	0.07	0.08	0.09	0.11	0.14	0.3
0.30	0.70	1.70	0.40	0.30	0.16	0.11	0.09	0.09	0.07
0.07	0.06	0.06	0.06						

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	0.50	0.10	0.00	0.00

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO _____ OF _____

CHKD. BY _____ DATE _____ PROJECT _____

SUBJECT _____

END-OF-PERIOD-FLOW

IO	HR	MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO	DA	HR	MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1	01	00	1	0.05	0.00	0.03	0	1	02	1	15	101	0.00	0.00	0.00	0
1	01	15	2	0.05	0.00	0.03	0	1	02	1	30	102	0.00	0.00	0.00	0
1	01	30	3	0.05	0.00	0.03	0	1	02	1	45	103	0.00	0.00	0.00	0
1	01	45	4	0.05	0.00	0.03	0	1	02	2	00	104	0.00	0.00	0.00	0
1	01	00	5	0.05	0.00	0.03	0	1	02	2	15	105	0.00	0.00	0.00	0
1	01	15	6	0.03	0.00	0.03	0	1	02	2	30	106	0.00	0.00	0.00	0
1	01	30	7	0.03	0.00	0.03	0	1	02	2	45	107	0.00	0.00	0.00	0
1	01	45	8	0.11	0.07	0.03	0	1	02	3	00	108	0.00	0.00	0.00	0
1	01	00	9	0.14	0.11	0.04	0	1	02	3	15	109	0.00	0.00	0.00	0
1	01	15	10	0.33	0.27	0.03	0	1	02	3	30	110	0.00	0.00	0.00	0
1	01	30	11	0.30	0.24	0.03	0	1	02	3	45	111	0.00	0.00	0.00	0
1	01	45	12	0.70	0.61	0.03	0	1	02	4	00	112	0.00	0.00	0.00	0
1	01	00	13	1.70	1.57	0.03	0	1	02	4	15	113	0.00	0.00	0.00	0
1	01	15	14	1.40	1.27	0.03	0	1	02	4	30	114	0.00	0.00	0.00	0
1	01	30	15	0.33	0.27	0.03	0	1	02	4	45	115	0.00	0.00	0.00	0
1	01	45	16	0.16	0.13	0.03	0	1	02	5	00	116	0.00	0.00	0.00	0
1	01	00	17	0.11	0.08	0.02	0	1	02	5	15	117	0.00	0.00	0.00	0
1	01	15	18	0.07	0.05	0.03	0	1	02	5	30	118	0.00	0.00	0.00	0
1	01	30	19	0.09	0.06	0.03	0	1	02	5	45	119	0.00	0.00	0.00	0
1	01	45	20	0.07	0.04	0.02	0	1	02	6	00	120	0.00	0.00	0.00	0
1	01	00	21	0.07	0.04	0.02	0	1	02	6	15	121	0.00	0.00	0.00	0
1	01	15	22	0.06	0.03	0.02	0	1	02	6	30	122	0.00	0.00	0.00	0
1	01	30	23	0.06	0.03	0.02	0	1	02	6	45	123	0.00	0.00	0.00	0
1	01	45	24	0.06	0.03	0.03	0	1	02	7	00	124	0.00	0.00	0.00	0
1	01	00	25	0.00	0.00	0.00	0	1	02	7	15	125	0.00	0.00	0.00	0
1	01	15	26	0.00	0.00	0.00	0	1	02	7	30	126	0.00	0.00	0.00	0
1	01	30	27	0.00	0.00	0.00	0	1	02	7	45	127	0.00	0.00	0.00	0
1	01	45	28	0.00	0.00	0.00	0	1	02	8	00	128	0.00	0.00	0.00	0
1	01	00	29	0.00	0.00	0.00	0	1	02	8	15	129	0.00	0.00	0.00	0
1	01	15	30	0.00	0.00	0.00	0	1	02	8	30	130	0.00	0.00	0.00	0
1	01	30	31	0.00	0.00	0.00	0	1	02	8	45	131	0.00	0.00	0.00	0
1	01	45	32	0.00	0.00	0.00	0	1	02	9	00	132	0.00	0.00	0.00	0
1	01	00	33	0.00	0.00	0.00	0	1	02	9	15	133	0.00	0.00	0.00	0
1	01	15	34	0.00	0.00	0.00	0	1	02	9	30	134	0.00	0.00	0.00	0
1	01	30	35	0.00	0.00	0.00	0	1	02	9	45	135	0.00	0.00	0.00	0
1	01	45	36	0.00	0.00	0.00	0	1	02	10	00	136	0.00	0.00	0.00	0
1	01	00	37	0.00	0.00	0.00	0	1	02	10	15	137	0.00	0.00	0.00	0
1	01	15	38	0.00	0.00	0.00	0	1	02	10	30	138	0.00	0.00	0.00	0
1	01	30	39	0.00	0.00	0.00	0	1	02	10	45	139	0.00	0.00	0.00	0
1	01	45	40	0.00	0.00	0.00	0	1	02	11	00	140	0.00	0.00	0.00	0
1	01	00	41	0.00	0.00	0.00	0	1	02	11	15	141	0.00	0.00	0.00	0
1	01	15	42	0.00	0.00	0.00	0	1	02	11	30	142	0.00	0.00	0.00	0
1	01	30	43	0.00	0.00	0.00	0	1	02	11	45	143	0.00	0.00	0.00	0
1	01	45	44	0.00	0.00	0.00	0	1	02	12	00	144	0.00	0.00	0.00	0
1	01	00	45	0.00	0.00	0.00	0	1	02	12	15	145	0.00	0.00	0.00	0
1	01	15	46	0.00	0.00	0.00	0	1	02	12	30	146	0.00	0.00	0.00	0
1	01	30	47	0.00	0.00	0.00	0	1	02	12	45	147	0.00	0.00	0.00	0
1	01	45	48	0.00	0.00	0.00	0	1	02	13	00	148	0.00	0.00	0.00	0
1	01	00	49	0.00	0.00	0.00	0	1	02	13	15	149	0.00	0.00	0.00	0
1	01	15	50	0.00	0.00	0.00	0	1	02	13	30	150	0.00	0.00	0.00	0
1	01	30	51	0.00	0.00	0.00	0	1	02	13	45	151	0.00	0.00	0.00	0
1	01	45	52	0.00	0.00	0.00	0	1	02	14	00	152	0.00	0.00	0.00	0
1	01	00	53	0.00	0.00	0.00	0	1	02	14	15	153	0.00	0.00	0.00	0
1	01	15	54	0.00	0.00	0.00	0	1	02	14	30	154	0.00	0.00	0.00	0
1	01	30	55	0.00	0.00	0.00	0	1	02	14	45	155	0.00	0.00	0.00	0

BY ..... DATE .....

CHKD. BY ..... DATE .....

SUBJECT .....

LOUIS BERGER & ASSOCIATES INC

SHEET ..... OF .....

PROJECT .....

ROUTED FLOWS THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

STAGE	922.00	923.00	924.00	925.00	925.50	926.00	927.00	928.00	929.00
FLOW	0.00	155.00	438.00	829.00	1175.00	1629.00	2928.00	4675.00	6496.00
CAPACITY=	0	45	51	60	71	85	102	121	166	194
ELEVATION=	907	922	923	924	925	926	927	928	930	931

CREL	SPWID	COGW	EXPW	ELEVL	COGL	CAREA	EXPL
922.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COGD	EXPD	DAMWID
925.5	0.0	0.0	0.

STATION 2: PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

MO	DA	HR. MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1	01	0.15	1	0.25	0.	0	45.	922.0
1	01	0.30	2	0.50	0.	0.	45.	922.0
1	01	0.45	3	0.75	0.	0.	45.	922.0
1	01	1.00	4	1.00	0.	0.	45.	922.0
1	01	1.15	5	1.25	0.	0.	45.	922.0
1	01	1.30	6	1.50	0.	0.	45.	922.0
1	01	1.45	7	1.75	0.	0.	45.	922.0
1	01	2.00	8	2.00	7.	1	45.	922.0
1	01	2.15	9	2.25	37.	10.	45.	922.1
1	01	2.30	10	2.50	122.	28.	47.	922.1
1	01	2.45	11	2.75	286.	109.	48.	922.1
1	01	3.00	12	3.00	579.	285.	54.	922.4
1	01	3.15	13	3.25	1118.	565.	63.	922.5
1	01	3.30	14	3.50	1947.	1142.	77.	922.6
1	01	3.45	15	3.75	2899.	2231.	93.	922.8
1	01	4.00	16	4.00	3880.	3136.	104.	922.9
1	01	4.15	17	4.25	3771.	3640.	110.	922.9
1	01	4.30	18	4.50	3487.	3629.	110.	922.9
1	01	4.45	19	4.75	2960.	3254.	106.	922.8
1	01	5.00	20	5.00	2407.	2774.	99.	922.6
1	01	5.15	21	5.25	1939.	2235.	93.	922.5
1	01	5.30	22	5.50	1563.	1805.	87.	922.4
1	01	5.45	23	5.75	1255.	1470.	83.	922.3
1	01	6.00	24	6.00	1009.	1198.	78.	922.2
1	01	6.15	25	6.25	814.	1001.	74.	922.1
1	01	6.30	26	6.50	659.	824.	71.	922.1
1	01	6.45	27	6.75	534.	700.	67.	922.0

BY ..... DATE .....
CHKD. BY ..... DATE .....
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LOUIS BERGER & ASSOCIATES INC.

SHEET NO ..... OF .....
PROJECT .....

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SHEET NO ..... OF .....

PROJECT .....

1	01	7 00	28	7 00	402.	577	64	924	4
1	01	7 15	29	7 25	264	454	60	924	0
1	01	7 30	30	7 50	161	336	57	923	9
1	01	7 45	31	7 75	108	234	53	923	3
1	01	8 00	32	8 00	72	161	51	923	0
1	01	8 15	33	8 25	49	119	50	922	8
1	01	8 30	34	8 50	34	86.	48	922	5
1	01	8 45	35	8 75	23	61.	47	922	4
1	01	9 00	36	9 00	15	44	47	922	3
1	01	9 15	37	9 25	10	30	46	922	2
1	01	9 30	38	9 50	6	21	46.	922	1
1	01	9 45	39	9 75	3	14	46.	922	1
1	01	10 00	40	10 00	1.	9	45	922	1
1	01	10 15	41	10 25	0.	6.	45	922	0
1	01	10 30	42	10 50	0	3	45.	922	0
1	01	10 45	43	10 75	0	2	45	922	0
1	01	11 00	44	11 00	0	1.	45.	922	0
1	01	11 15	45	11 25	0	1	45.	922	0
1	01	11 30	46	11 50	0	0	45	922	0
1	01	11 45	47	11 75	0.	0.	45.	922	0
1	01	12 00	48	12 00	0.	0.	45.	922	0
1	01	12 15	49	12 25	0	0	45.	922	0
1	01	12 30	50	12 50	0.	0	45.	922	0
1	01	12 45	51	12 75	0	0	45	922	0
1	01	13 00	52	13 00	0	0	45.	922	0
1	01	13 15	53	13 25	0.	0	45.	922	0
1	01	13 30	54	13 50	0	0	45.	922	0
1	01	13 45	55	13 75	0.	0	45.	922	0
1	01	14 00	56	14 00	0	0	45.	922	0
1	01	14 15	57	14 25	0	0	45	922	0
1	01	14 30	58	14 50	0	0.	45.	922	0
1	01	14 45	59	14 75	0.	0	45.	922	0
1	01	15 00	60	15 00	0.	0.	45.	922	0
1	01	15 15	61	15 25	0	0.	45.	922	0
1	01	15 30	62	15 50	0	0	45.	922	0
1	01	15 45	63	15 75	0.	0	45.	922	0
1	01	16 00	64	16 00	0.	0.	45.	922	0
1	01	16 15	65	16 25	0.	0.	45.	922	0
1	01	16 30	66	16 50	0.	0.	45.	922	0
1	01	16 45	67	16 75	0	0	45.	922	0
1	01	17 00	68	17 00	0	0.	45.	922	0
1	01	17 15	69	17 25	0	0	45	922	0
1	01	17 30	70	17 50	0.	0.	45.	922	0
1	01	17 45	71	17 75	0.	0.	45.	922	0
1	01	18 00	72	18 00	0.	0.	45.	922	0
1	01	18 15	73	18 25	0	0	45.	922	0
1	01	18 30	74	18 50	0.	0.	45.	922	0
1	01	18 45	75	18 75	0	0	45	922	0
1	01	19 15	77	19 25	0.	0.	45.	922	0
1	01	19 30	78	19 50	0.	0	45	922	0
1	01	19 45	79	19 75	0	0.	45.	922	0
1	01	20 00	80	20 00	0	0.	45.	922	0
1	01	20 15	81	20 25	0	0	45.	922	0
1	01	20 30	82	20 50	0	0	45.	922	0
1	01	20 45	83	20 75	0	0	45	922	0
1	01	21 00	84	21 00	0	0	45	922	0
1	01	21 15	85	21 25	0	0	45.	922	0
1	01	21 30	86	21 50	0	0	45	922	0
1	01	21 45	87	21 75	0	0	45	922	0
1	01	22 00	88	22 00	0	0	45.	922	0
1	01	22 15	89	22 25	0	0	45	922	0
1	01	22 30	90	22 50	0	0	45	922	0
1	01	22 45	91	22 75	0	0	45	922	0
1	01	23 00	92	23 00	0	0	45	922	0
1	01	23 15	93	23 25	0	0	45	922	0
1	01	23 30	94	23 50	0	0	45	922	0
1	01	23 45	95	23 75	0	0	45	922	0
1	02	0 00	96	24 00	0	0	45	922	0
1	02	0 15	97	24 25	0	0	45	922	0
1	02	0 30	98	24 50	0	0	45	922	0
1	02	0 45	99	24 75	0	0	45	922	0
1	02	1 00	100	25 00	0	0	45	922	0

PEAK OUTFLOW IS 3640 AT TIME 4 25 HOURS

CFS	3640	1328	335	161	32138.
CMS	103	38	9	5.	910
INCHES		4 26	4 30	4 30	4 30
MM		108 20	109 10	109 10	109 10
AC-FT		659	664	664	664
THOUS CU M		812	819	819	819

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO _____ OF _____

CHKD. BY _____ DATE _____ PROJECT _____

SUBJECT _____

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

				RATIOS APPLIED TO FLOWS
OPERATION	STATION	AREA	PLAN	RATIO 1
				1.00
HYDROGRAPH AT	1	2.90	1	3771
		(7.51)		(106.77)(
ROUTED TO	2	2.90	1	3640
		(7.51)		(103.07)(

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	922.00	922.00	925.50
STORAGE	45.	45.	78
OUTFLOW	0.	0	1175

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	927.43	1.93	110.	3640	2.50	4.25	0.00

END

DATE
FILMED

6-81

DTIC